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Provisional specification in connection with Application No. PQ 2940 for a
patent by BRITAX RAINSFORDS PTY LTD filed on 20 September 1999.

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ORIGINAL

AUSTRALIA

PATENTS ACT 1990

PROVISIONAL SPECIFICATION FOR AN INVENTION ENTITLED:-

"POWERED MIRROR ASSEMBLY CURRENT SENSING CIRCUIT"

This invention is described in the following statements:-

This invention relates to a vehicle mirror motor control used in moving a mirror between an in-use position and a parked position, in particular to a circuit which effectively turns off electric current to the motor as the mirror reaches the end of its intended travel when being folded back or moved to an operative position.

5 However, it will be appreciated that such a circuit is useable in other apparatus which use electric motors and require the effective turn-off of the kind described.

BACKGROUND

10 A side mounted vehicle rear view mirror is normally pivotally mounted to a vehicle mounting bracket so that it can be forwardly or rearwardly rotated relative to the vehicle. In an operative or in-use position it is located laterally of the vehicle body and in a folded or parked position is located approximately parallel to the side of the vehicle so as to prevent damage to the mirror and mirror housing. Such a folded position is useful when the vehicle is parked on roadways or being taken
15 through a car wash.

Motorised versions which fold mirrors in the manner described above are referred to as power fold mirrors and can be arranged with appropriate control electronics to move to a folded position when a button is pressed or upon the
20 vehicle's ignition being turned off or alternatively the gear selector being placed in the parked position.

It is typical at this time for the motor used to drive the folding mechanism to be provided power until the current driving the motor is raised substantially above
25 normal levels (over current) for a predetermined period of time. This can result from the mirror head coming against a stop. This manner of motor control is cheap to design, but not necessarily cheap to build and typically needs to include expensive transient suppression components. An alternative is to use expensive and potentially unreliable limit switches.

30

Periods of over current are an undesirable feature of prior power fold mirror designs as this can ultimately lessen the life of the electric motor and its associated

drive train components or can cause unexpected failure as well as being wasteful of power. Furthermore, as the effects of spurious electromagnetic (em) emissions are sometimes unpredictable especially upon vehicle electronic systems it is advantageous to eliminate or keep to an acceptable minimum this type of emission.

5

It is also typical that the motor used to drive powered mirrors are direct current (d.c.) motors which require a specific polarity of current to drive them in a desired direction and this tends to complicate the design of typical motor drive circuits.

10

It is an aim of this invention to eliminate or reduce the abovementioned problems.

BRIEF DESCRIPTION OF THE INVENTION

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In a broad aspect of the invention a motor control circuit for a direct current electric motor (having two current inputs) used to actuate an element between a first and second position, comprises

a pair of unipolar electronic control circuits connected respectively between a source of direct current and a respective said current input, each of said control

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circuits comprising,

a solid state switch located between a said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,

25

current limiting means for adjusting said input bias signal according to the current flowing through said motor,

switching means for adjusting said input bias to said solid state switch such that no current flows through said motor when a predetermined period of current limiting has occurred such as when said motor has actuated said element to a first or second position.

30

In a further aspect of the invention a control system for a direct current electric motor wherein said current limiting means is temperature compensated.

Specific embodiments of the invention will now be described in some further detail with reference to and as illustrated in the accompanying figures. These
5 embodiments are illustrative, and not meant to be restrictive of the scope of the invention. Suggestions and descriptions of other embodiments may be included but they may not be illustrated in the accompanying figures or alternatively features of the invention may be shown in the figures but not described in the specification.

10 **BRIEF DESCRIPTION OF THE DRAWINGS**

Fig 1 depicts a functional block diagram of a motor control circuit according to one embodiment of the invention, incorporating a circuit for each direction of motor operation;

15 Fig 2 depicts a circuit of both unipolar circuits for controlling the motor;

Fig 3 depicts the portion of one of the unipolar circuits which is functional during normal running of the motor as it actuates the motor between a first and second position;

Fig 4 depicts the portion of one of the unipolar circuits which is used to limit
20 the current provided to the motor as well as temperature compensate the current limiting function; and

Fig 5 depicts the portion of one of the unipolar circuits which is used to abruptly cut off current to the motor after a period of current limiting.

25 **DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION**

Fig 1 depicts a functional block diagram of a motor control circuit which has been found useful to control a motor used to actuate the folding and un-folding of a mirror housing between an extended and folded position.

30 However, any motor which has the task of moving an element between two positions could be controlled by such a circuit. Thus, even though the description

provided herein is directed to outside rear view mirrors and their fold back function, the circuit is capable of being applied to motors requiring similar functionality.

The motor 10 is located between a positive (+) and negative (-) source of electrical current and dependent on the polarity of current applied to the motor the shaft of the motor will turn in a predetermined direction. Thus to change the direction of the motor, the supply current polarity is swapped, which can be easily done by controlling the position of a switch or switch-like device (not shown).

In the example of an outside rear view mirror housing which is foldable relative to the vehicle body between a folded position and a lateral position, a single electric motor can be connected to a mechanical means for translating the rotational motion of the motor's shaft into a movement of the mirror housing between the described positions.

In the past when the mirror housing reached the end of its travel, the motor would draw large amounts of current until the relatively high current being drawn was detected and used to trigger the cut-off of the supply current.

As will be described in more details in this application the invention has two major features which simplify and facilitate an alternative way to control an electric motor used in a foldable outside rear view mirror.

In this invention the approach is to switch off current to the motor after current to the motor has been limited to a maximum level for a predetermined time.

Fig 1 depicts two unipolar circuits one each side of the motor 10. Only one side of the circuit diagram will be described as the other side is identical. The opposite side of the circuit comes into operation upon a change of the polarity of the source current. However, it will be apparent that there is always a conduction path through the opposite side to that which is operational so as to complete the circuit back to the current source.

A solid state switch 12 is located between one of the current inputs 14 of the motor 10 and the current source.

5 This switch 12 is used to control the amount of current which flows through the motor as well as to switch off current to the motor once the end of travel has been reached.

10 A current limiting circuit 16 is located between the switch 12 and the source of current, in this case a positive current terminal. To provide consistency of operation over a reasonable environmental temperature variation, a temperature compensation circuit 18 is provided but this is an option rather than a necessity for the operation of such a motor in the majority of circumstances.

15 During normal operation of the motor, the switch 12 is controlled by bias control circuit 20 which ensures that the switch is set so as to pass current directly to the motor 10.

20 Once the mirror housing or element actuated by the motor has reached the end of its travel a prompt cut-off of current to the motor is desirable and cut-off circuit 22 performs this function based on a predetermined period of active current limiting which is provided by circuit 16 once the end of travel is approaching or reached.

25 Fig 2 depicts a complete circuit for a foldable outside rear view mirror housing motor RM. The circuit is substantially symmetric so that one side can operate when one polarity of current is applied and other side can operate when the opposite polarity of current is applied. The common components being R1 and R2.

30 Fig 3 depicts those components of the circuit which are primarily active during the application of current such that terminal X4 has a positive polarity and the motor RM is running.

Current flows through the diode of Q4 (a parasitic diode which is available in transistors of this general type), through the motor RM, through Q1 and through current sense resistors R8 and R9.

5

Switching transistor Q1 is the same as Q4 and is biased into conduction through its source and sink by a voltage supplied via D1, R1, R2 and R4. This voltage is sufficient to turn-on Q1 so that sufficient current can flow through the motor to drive the mechanism to which it is mechanically coupled.

10

Fig 4 depicts those particular components of the circuit which are primarily active during the function of limiting current through the motor. During normal operation the current through R8 and R9 is such that the base voltage on Q3 is insufficient to cause Q3 to conduct between its collector and emitter. However, as the level of current flowing through the motor increases, the voltage on the base of Q3 increases and Q3 will begin to turn-on and conduct. As Q3 conducts more current, there is a reduction of on-bias of the main current switch Q1 via R4. Q1 thus conducts less current and current to the motor RM is thereby limited.

15

20

It is preferable however that the current limiting process be substantially consistent even with fluctuating temperature. Temperature compensation can be provided to accommodate a drive voltage of the main bipolar transistor Q1 which changes by approximately -1% for every +3°C.

25

In this embodiment collector current Q3 is provided via a thermistor R2 which has a negative temperature co-efficient. Thus as the ambient and component temperature rises, the current through the thermistor increases and the collector current through Q3 increases which partly off-sets the falling base voltage in Q3.

30

The increase in current through the thermistor R2 with increasing temperature will cause an increased voltage across R7. This voltage reduces the voltage base appearing across the emitter junction of Q3. The effect is to off-set the reduction in

base emitter voltage required by Q3 with increased temperature. R7 and R2 are chosen to give a best fit current versus temperature curve. R1 limits the maximum current that can flow when very high temperatures are experienced by the system.

5 Referring to Fig 5, when current limiting is occurring, the voltage across the solid state switch Q1 increases, hence reducing the voltage across the motor and with it the current. As the voltage across Q1 increases it also charges C1 via R3. Over a period of time C1 charges to a voltage such that Q2 turns-on and begins to conduct which in turn reduces the drive voltage of the main bi-polar transistor solid state
10 switch Q1.

This process accelerates as the period of current limiting increases and as current is reduced further the voltage across Q1 increases but raises the relative level of the base voltage on Q2 which in turn conducts more and thus brings down sharply
15 the bias voltage applied to the main bi-polar transistor solid state switch Q1. This condition quickly reduces to substantially zero the conduction through Q1 and thereby the current flow which operates the motor.

R4 is chosen to keep to a minimum the current drawn by the circuit while Q1
20 is in the off-state.

With the exception of small bias currents, all primary current paths are conducted through the motor which is advantageous since transient voltage excursions from the supply are limited by the resistance and induction of the motor
25 windings. A consequence of this design feature is that there is a reduced need for transient protection components.

A further advantage of the circuit design, is the use of current limiting and the period of current limiting being used to determine the cut-off condition for current
30 flowing through the motor. This is likely to result in less stress (mechanical and electrical) upon the motor when the mechanism to which it is connected reaches the

end of its travel and also improves the Mean Time Between Failure (MTBF) of the motor actuated element.


5 Even though the circuit is arranged to detect an increasing current condition through the motor it does not necessarily know if this condition has occurred because the mechanism it actuates has actually reached one of its end of travel positions. Such a condition could occur if the mechanism is stopped unexpectedly intermediate its end of travel positions. Other sensors and circuits can then be used to ensure that the intended end of travel position has in fact been reached but these
10 are not central to the problem addressed by the invention disclosed in this specification.

It will be appreciated by those skilled in the art, that the invention is not restricted in its use to the particular application described and neither is the present
15 invention restricted in its preferred embodiment with regard to the particular elements and/or features described or depicted herein. It will be appreciated that various modifications can be made without departing from the principles of the invention, therefore, the invention should be understood to include all such modifications within its scope.

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Dated this 20th day of September, 1999.

BRITAX RAINSFORDS PTY LTD
By its Patent Attorneys
25 MADDERNS



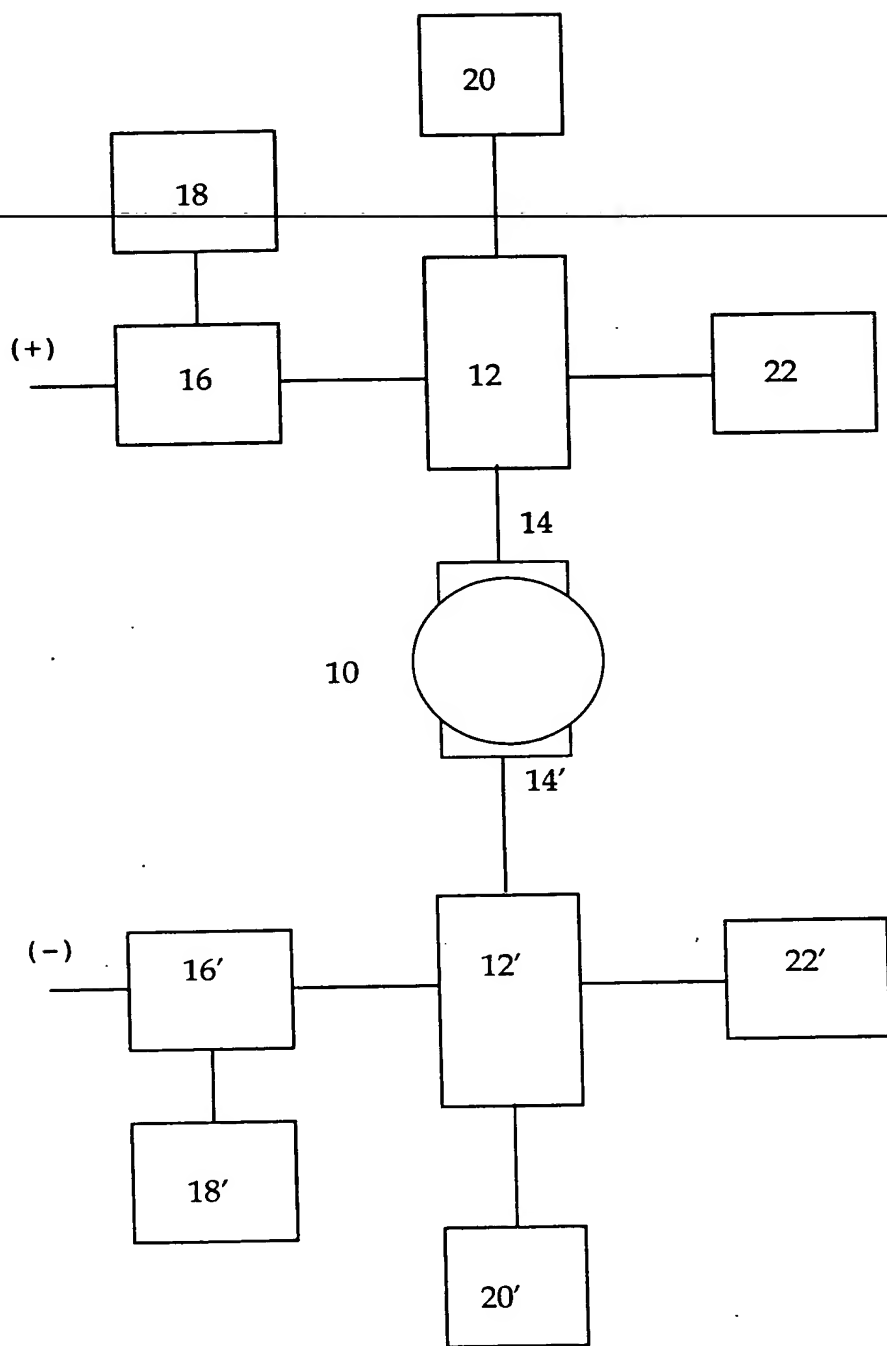


FIG. 1

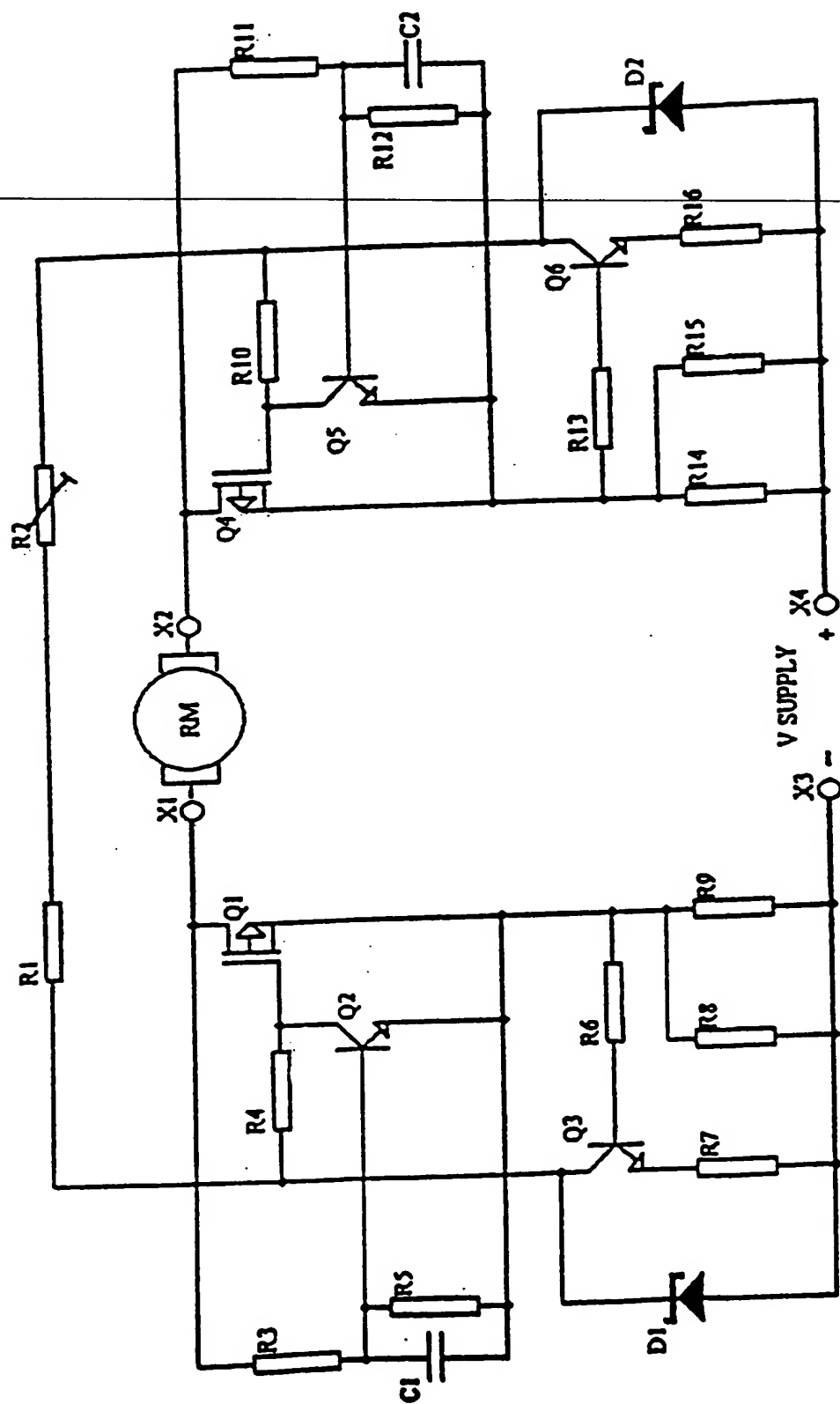


FIG. 2

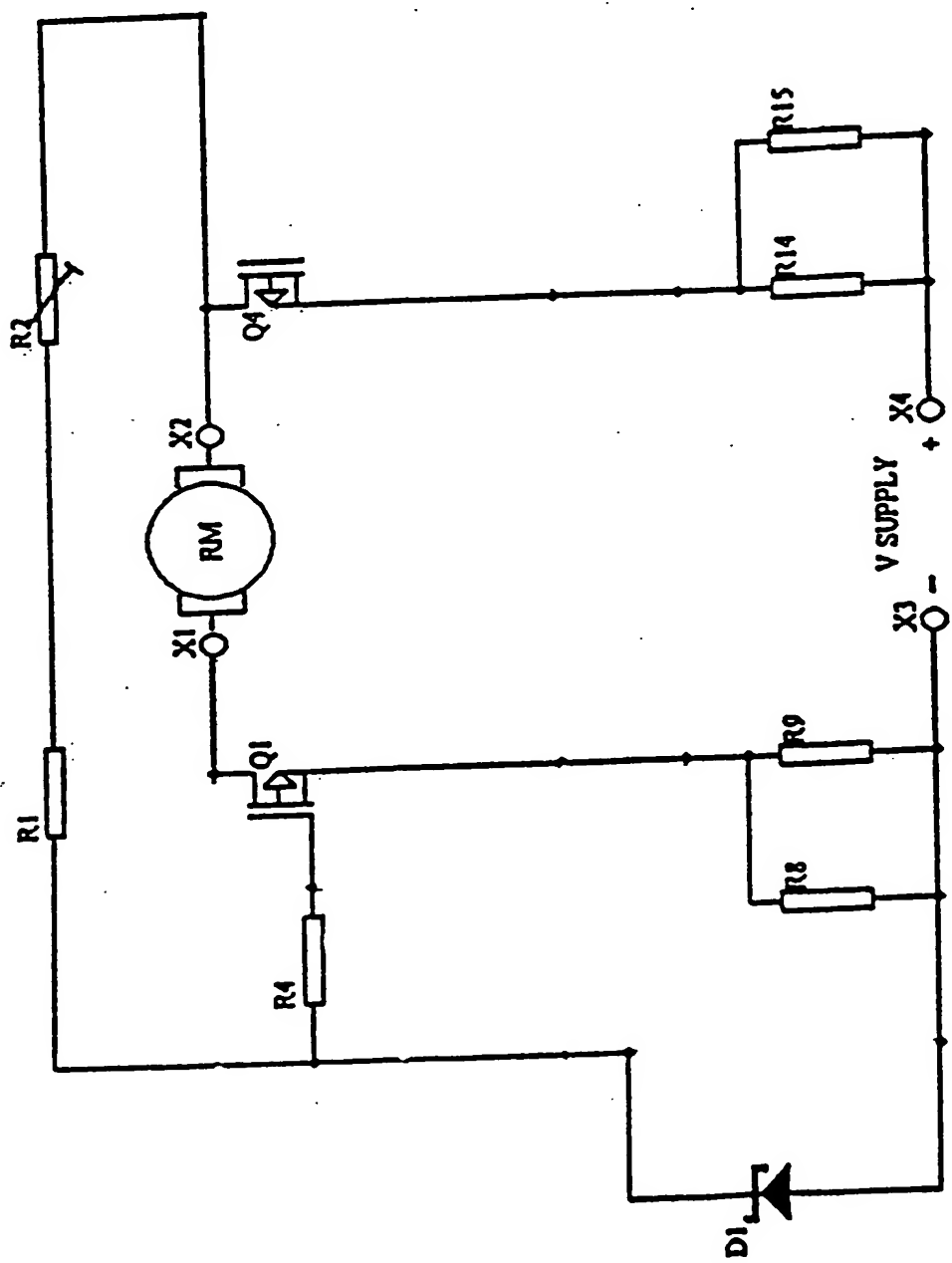


FIG. 3

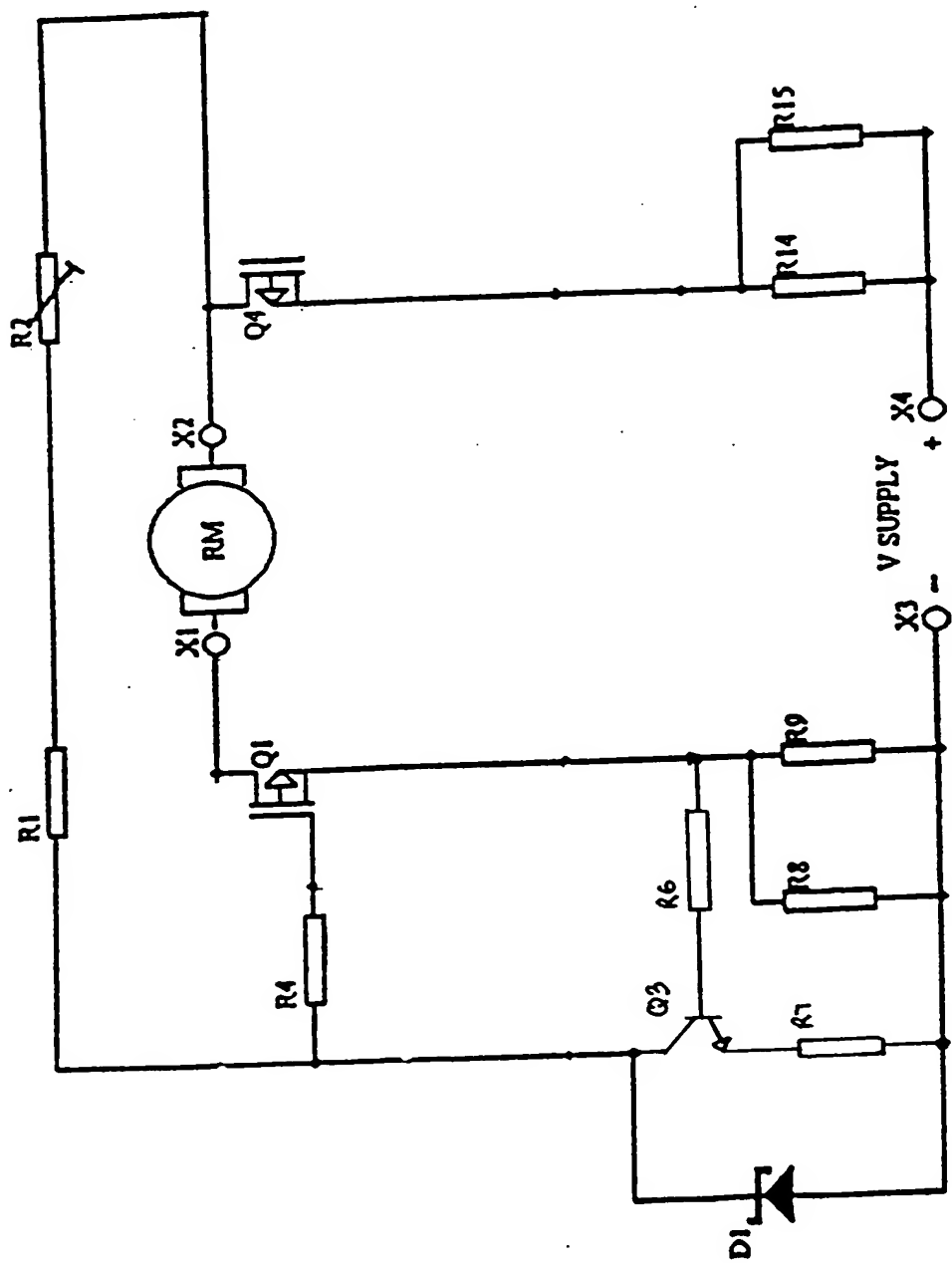


FIG. 4

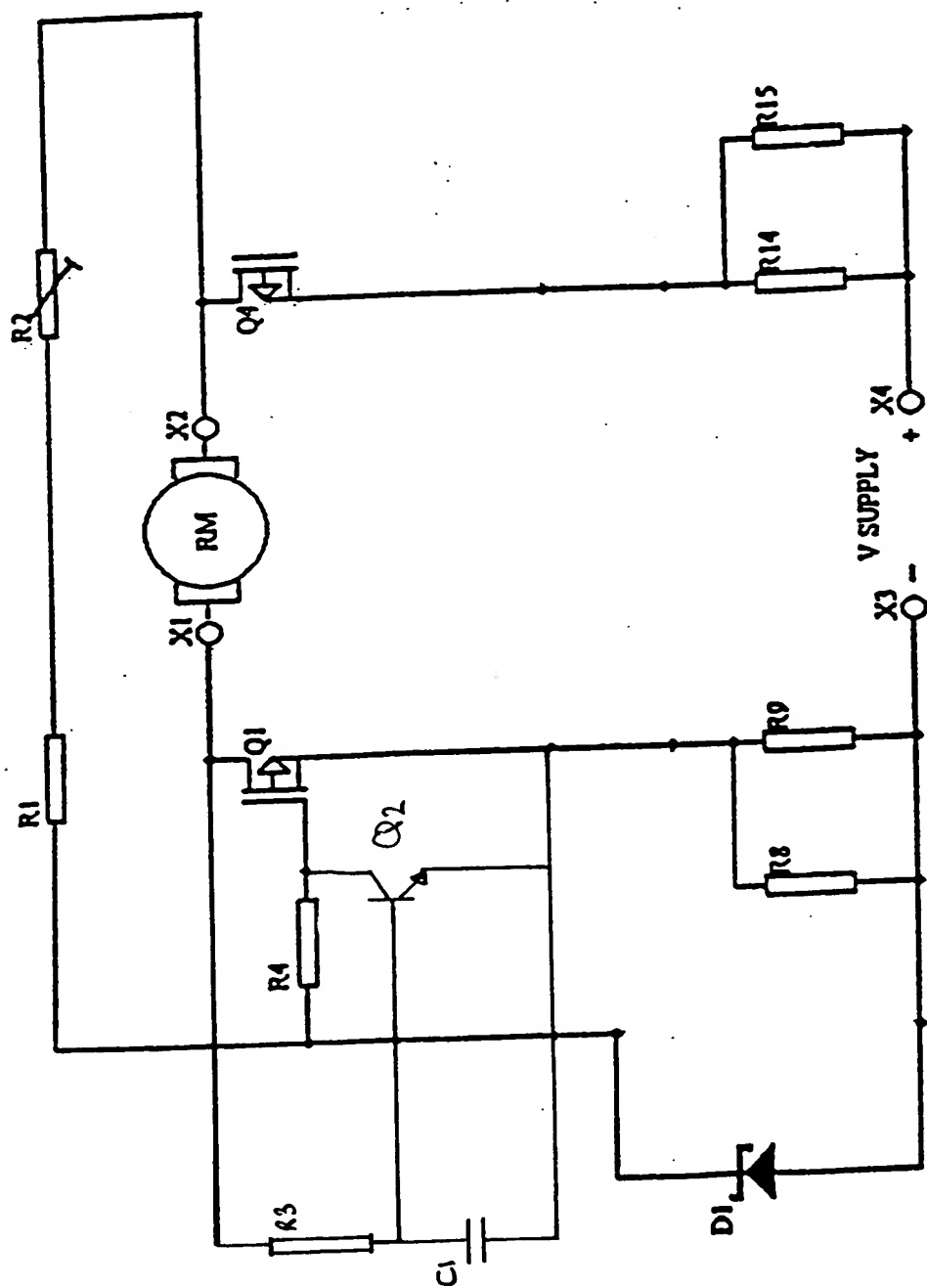


FIG. 5

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